



US009273773B2

(12) **United States Patent**  
**Vukojcic**

(10) **Patent No.:** **US 9,273,773 B2**  
(45) **Date of Patent:** **Mar. 1, 2016**

(54) **ONE-PIECE INERTIA RING AND METHOD OF MANUFACTURING THE ONE-PIECE INERTIA RING**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **MAGNA Powertrain, Inc.**, Concord (CA)  
(72) Inventor: **Dejan Vukojcic**, Richmond Hill (CA)  
(73) Assignee: **Magna Powertrain, Inc.**, Concord (CA)  
(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 79 days.

2,473,335 A \* 6/1949 Hardy ..... F16F 15/1442  
29/463  
2,784,016 A \* 3/1957 Heimbuch ..... F04D 29/126  
277/372  
2,827,225 A \* 3/1958 Killian ..... F16H 55/44  
29/892.11  
2,882,747 A \* 4/1959 Haushalter ..... F16F 15/1442  
188/264 R  
3,371,549 A \* 3/1968 Schrempp ..... F16H 55/14  
474/161  
3,994,181 A \* 11/1976 Sproul ..... F16H 55/44  
29/892.3  
4,220,056 A \* 9/1980 Bremer, Jr. .... F16F 15/1442  
74/574.4  
4,378,865 A \* 4/1983 McLean ..... F16F 15/1442  
188/379  
4,710,152 A \* 12/1987 Ichikawa ..... F16F 15/126  
474/166

(21) Appl. No.: **14/204,148**

(22) Filed: **Mar. 11, 2014**

(65) **Prior Publication Data**

US 2014/0329629 A1 Nov. 6, 2014

(Continued)

FOREIGN PATENT DOCUMENTS

CN 201953952 U 8/2011  
EP 0101015 A1 2/1984

(Continued)

OTHER PUBLICATIONS

International Search Report Mailed Nov. 4, 2014.

(Continued)

*Primary Examiner* — Henry Liu

(74) *Attorney, Agent, or Firm* — Dickinson Wright PLLC

(60) Provisional application No. 61/787,537, filed on Mar. 15, 2013.

(51) **Int. Cl.**  
**F16D 3/00** (2006.01)  
**F16H 55/14** (2006.01)  
**F16H 55/36** (2006.01)  
**F16F 15/12** (2006.01)

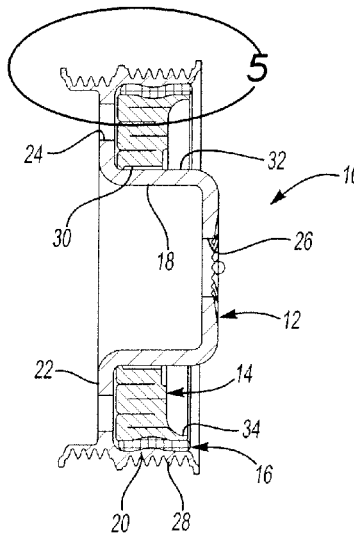
(52) **U.S. Cl.**  
CPC ..... **F16H 55/36** (2013.01); **F16F 15/1203**  
(2013.01); **F16H 2055/366** (2013.01)

(58) **Field of Classification Search**  
CPC .. F16H 2055/366; F16H 55/36; F16F 15/126;  
F16F 15/1442; Y10T 74/2131  
USPC ..... 474/94, 166  
See application file for complete search history.

(57) **ABSTRACT**

A harmonic damper for use in vehicular accessory drive systems. The harmonic damper includes a one-piece inertia ring manufactured from a sheet metal blank using a cold forming process to define a series of interconnected folded ring sections.

**20 Claims, 5 Drawing Sheets**



(56)

**References Cited**

## U.S. PATENT DOCUMENTS

4,882,944	A *	11/1989	Vohl	F16F 15/126 474/166
5,140,868	A *	8/1992	Mizuno	F02B 75/06 474/166
5,425,287	A *	6/1995	Beattie	F16F 15/1442 464/180
5,441,456	A *	8/1995	Watanabe	B21D 53/261 29/892.11
5,449,322	A *	9/1995	Wagner	F16F 15/1442 464/90
5,453,056	A *	9/1995	Ullrich	F16F 15/1442 474/161
5,465,485	A *	11/1995	Miyake	F16F 15/126 29/892.11
5,540,626	A *	7/1996	Asai	F16F 15/124 474/178
5,562,544	A *	10/1996	Ochs	F16F 15/1442 464/89
5,591,093	A *	1/1997	Asai	F16D 3/76 474/902
5,611,416	A *	3/1997	Berger	F16D 35/005 192/104 F
5,843,264	A *	12/1998	Mabuchi	F16F 1/44 156/219
5,931,051	A *	8/1999	Ott	F16F 15/1485 74/574.4
5,988,015	A *	11/1999	Riu	F16F 15/124 464/90
6,026,709	A *	2/2000	Depp	F16F 15/126 464/180
6,062,104	A *	5/2000	Allport	F16F 15/124 192/66.1
6,106,421	A *	8/2000	Graber	F16F 15/126 474/94
6,386,065	B1 *	5/2002	Hodjat	F16F 15/126 474/94
6,684,735	B2 *	2/2004	Watanabe	F16F 15/1203 428/450
6,875,113	B2 *	4/2005	Nichols	F16F 15/1442 464/90
7,047,644	B2 *	5/2006	Hodjat	F16F 15/126 29/892
7,055,243	B2 *	6/2006	Hodjat	B21D 53/261 29/892.11
7,150,679	B2 *	12/2006	Pape	F16F 15/126 464/17
7,178,423	B2	2/2007	Breese et al.	
7,197,959	B2 *	4/2007	Crissy	F16F 15/126 464/90
7,204,772	B2 *	4/2007	Huber	F16D 3/68 474/94
7,300,372	B2 *	11/2007	Riu	F16F 15/126 464/90
7,437,808	B2	10/2008	Hodjat	
7,850,557	B2 *	12/2010	Moriya	F16H 55/36 464/90
8,091,450	B2	1/2012	Manzoor et al.	
8,162,762	B2 *	4/2012	Himmelmann	F16D 3/74 310/75 D
8,202,183	B2 *	6/2012	Riu	F16D 41/203 474/70
8,231,488	B2 *	7/2012	Amati	H02K 7/1012 474/166
8,302,753	B2	11/2012	Antchak et al.	
2003/0199348	A1 *	10/2003	Huber	F16D 3/68 474/94
2004/0166974	A1 *	8/2004	Hodjat	F16F 15/126 474/94
2004/0255719	A1	12/2004	Schmidt	
2006/0030441	A1 *	2/2006	Watanabe	F16F 15/126 474/166
2006/0094547	A1 *	5/2006	Xu	F16F 15/126 474/94
2006/0172832	A1 *	8/2006	Watanabe	F16F 15/126 474/94
2006/0293137	A1 *	12/2006	Lopes	F16F 15/1442 474/166
2007/0249442	A1 *	10/2007	Grunau	F16F 15/1442 474/94
2008/0076611	A1 *	3/2008	Fisher	F02B 67/06 474/178
2009/0000422	A1 *	1/2009	Christenson	F16F 7/108 74/574.4
2009/0105021	A1 *	4/2009	Amati	H02K 7/1012 474/94
2010/0029422	A1 *	2/2010	Riu	F16D 3/14 474/94
2010/0099527	A1 *	4/2010	Rolando	F16F 15/1442 474/94
2012/0094791	A1 *	4/2012	Lee	F16F 15/126 474/94
2012/0231909	A1 *	9/2012	Shin	F16F 15/126 474/94
2013/0095964	A1 *	4/2013	Shin	F16F 15/126 474/94

## FOREIGN PATENT DOCUMENTS

EP	620380	A1	10/1994
EP	1382886	A1	1/2004
GB	1534675	A	12/1978
WO	2010054935	A1	5/2010

## OTHER PUBLICATIONS

Written Opinion Dated Oct. 30, 2014.

\* cited by examiner

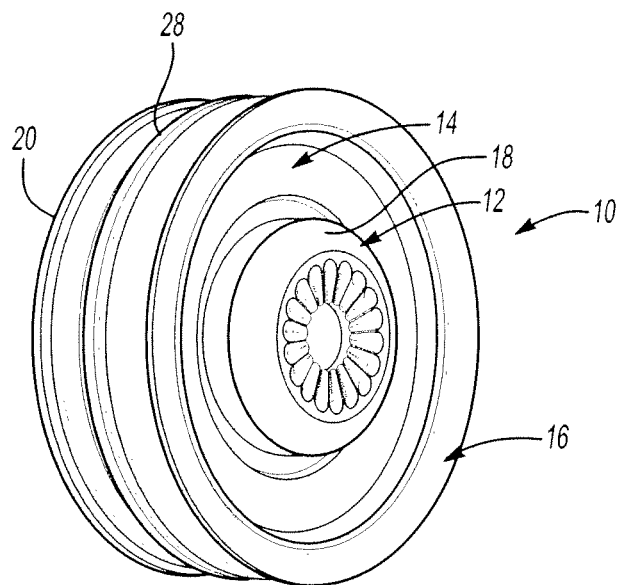


Fig-1

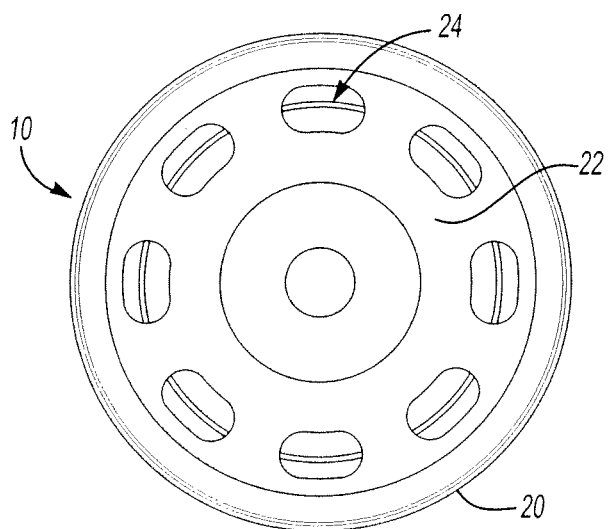


Fig-2

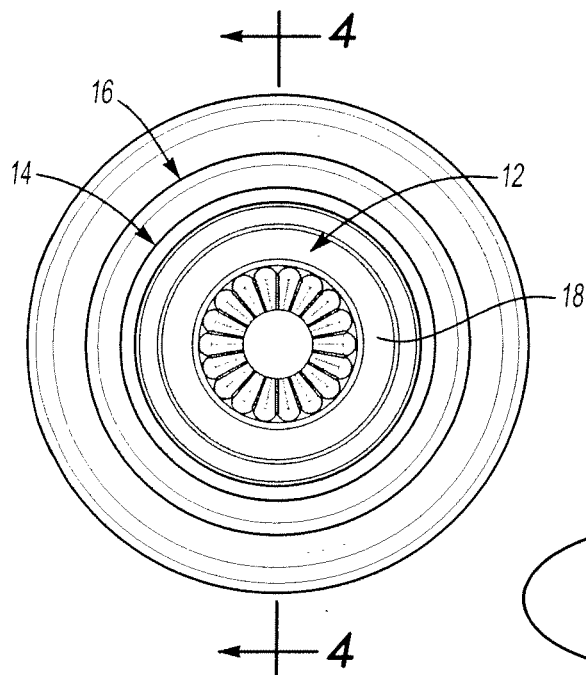


Fig-3

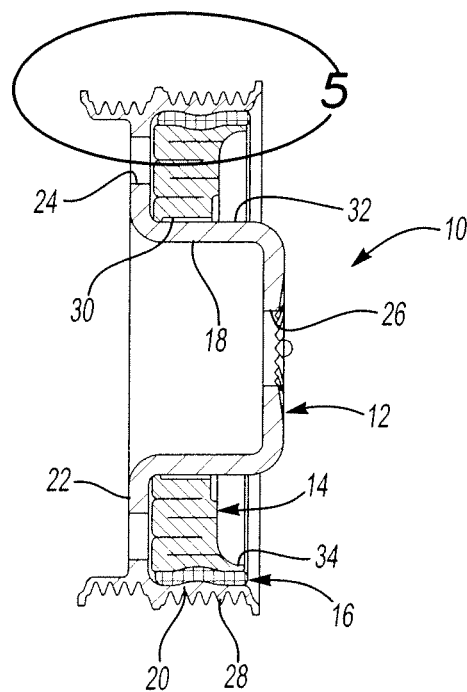


Fig-4

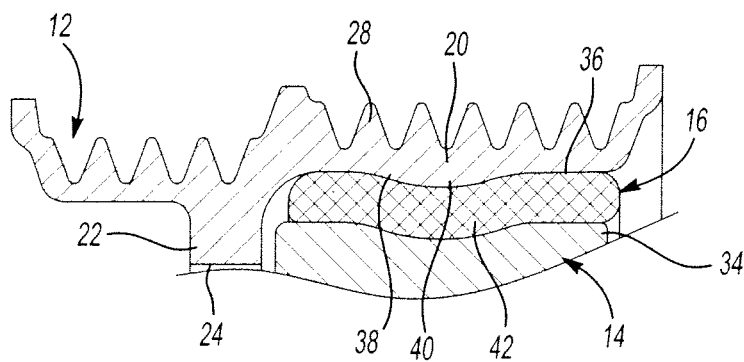


Fig-5

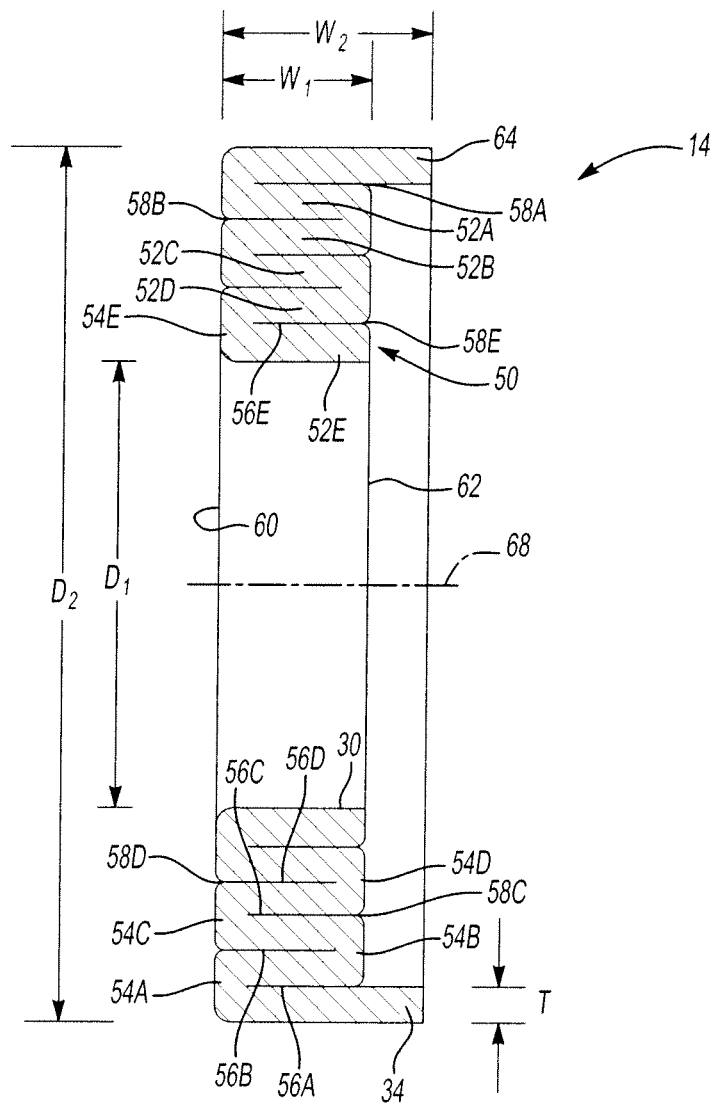


Fig-6

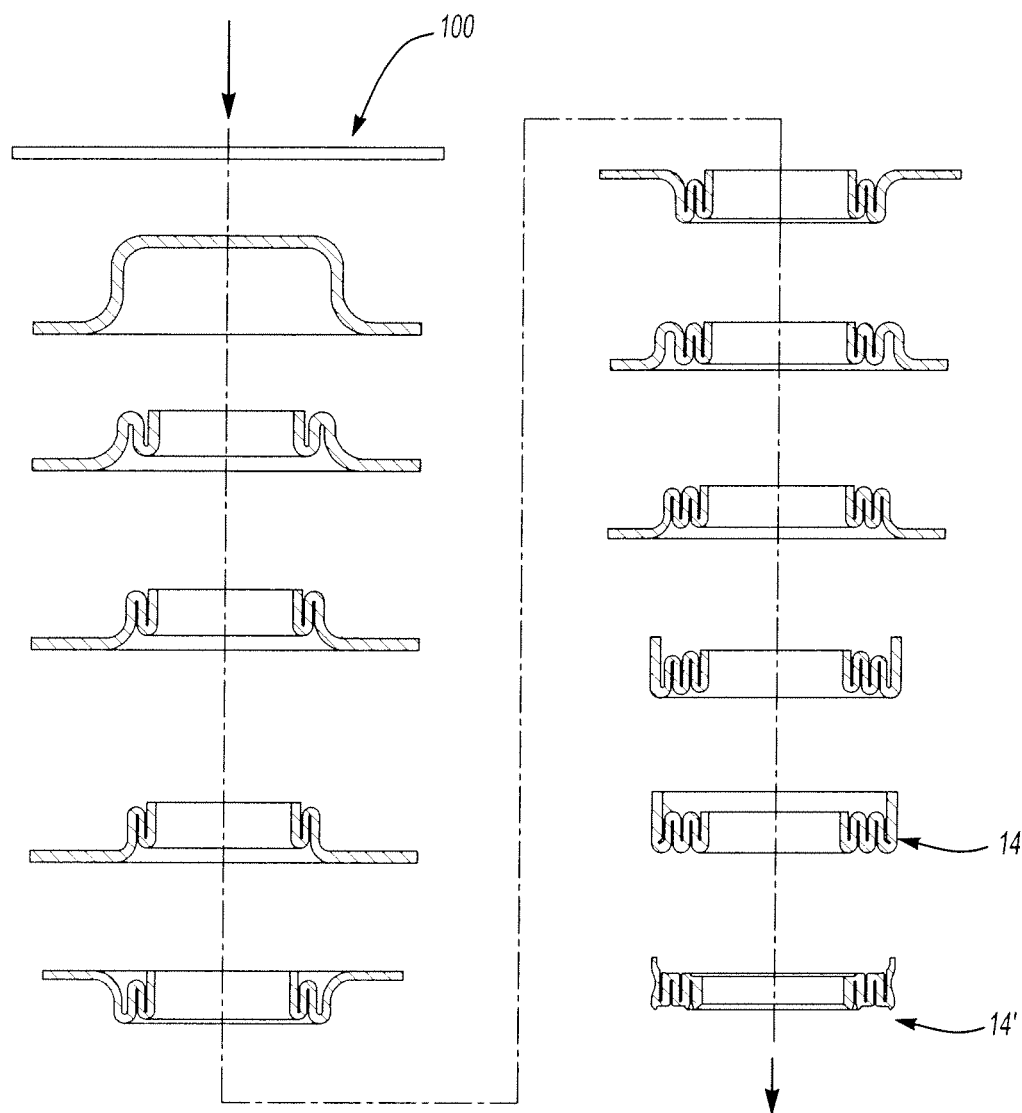
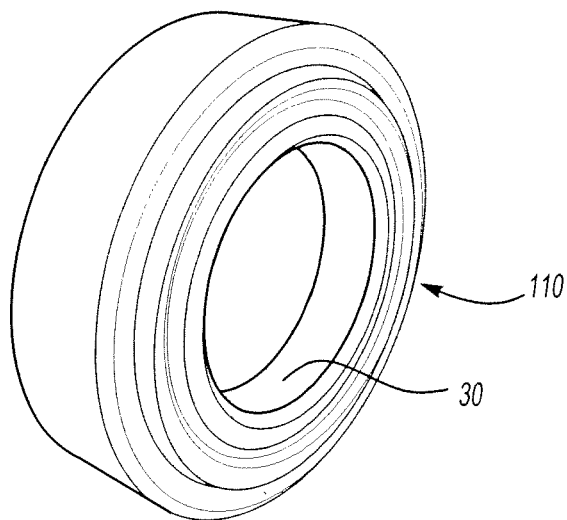
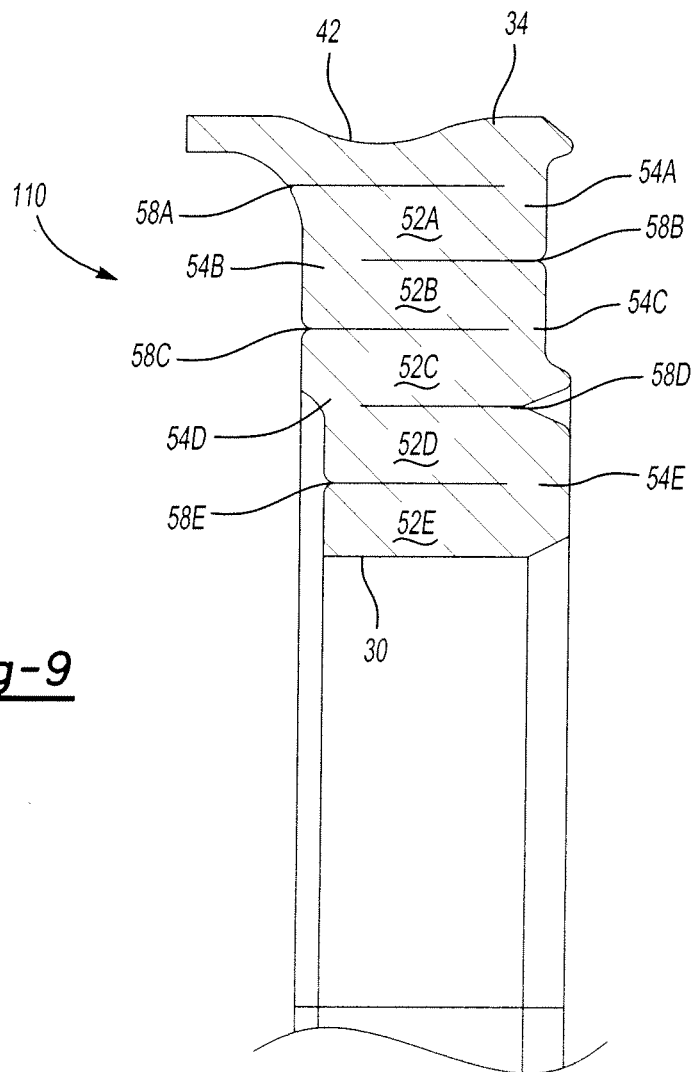


Fig-7



**Fig-8**



**Fig-9**

1

# ONE-PIECE INERTIA RING AND METHOD OF MANUFACTURING THE ONE-PIECE INERTIA RING

## CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/787,537 filed Mar. 15, 2013. The entire disclosure of the above application is incorporated herein by reference.

## FIELD

The present disclosure relates generally to formed components for use in automotive applications. More specifically, the present disclosure relates to harmonic dampers for use with internal combustion engine accessory drive systems and, in particular, to a one-piece inertia ring for use with harmonic dampers and a method of manufacturing the one-piece inertia ring using a forming process.

## BACKGROUND

This section provides background information related to the present disclosure which is not necessarily prior art.

Virtually all motor vehicles equipped with internal combustion engines incorporate a "serpentine" drive belt system having a single endless drive belt and a series of pulleys. The pulleys derive rotary power from the endless drive belt and operate to drive various vehicle accessories such as, for example, the engine fan, the power steering pump, the water pump, the alternator and the air conditioning compressor. The endless drive belt that drives each of these accessory pulleys is, in turn, driven by an engine pulley that is connected to the crankshaft of the internal combustion engine. To reduce the transfer of vibrations and oscillations between the crankshaft and the serpentine drive belt system, the engine pulley, sometimes referred to as the "crankshaft pulley", may include a torsional vibration damper that functions to reduce the amplitude of the angular vibrations delivered by the crankshaft.

Integrated crankshaft pulley-torsional damper units, commonly referred to as "crankshaft dampers", may include a hub configured to be rigidly connected to the crankshaft, a driven member, and at least one ring of elastomeric material connecting the hub to the driven member. The elastomeric material functions to filter/absorb the torsional oscillations transferred to the hub from the crankshaft. In many instances, the hub includes an integral pulley and the driven member is an inertia ring. The elastomeric material is typically compressed between the pulley and the inertia ring to provide the requisite slip torque for absorbing the torsional vibration.

Automotive pulleys can be made by spinning sheet metal using a number of different processes known in the industry. However, crankshaft dampers typically must be stronger and more massive than ordinary sheet metal pulleys. Specifically, a greater mass is required to provide the requisite amount of inertia to absorb crankshaft vibration. As such, many pulleys and inertia rings associated with crankshaft dampers are made from forgings or castings. Unfortunately, the expense and time required to machine these components is prohibitive. As an alternative, some components of the crankshaft damper can be flow formed from sheet metal but can only be made up to a certain blank thickness in terms of economics and practicality.

In view of the above, there is a recognized need in the field of automotive harmonic dampers generally and crankshaft

2

dampers specifically to manufacture components, such as inertia rings, using alternative manufacturing processes for reducing expense and providing high quality components.

## SUMMARY

This section provides a general summary of the disclosure and is not intended to be a comprehensive disclosure of all of the features, aspects and objects of the inventive concepts to be described in detail hereinafter.

It is an aspect of the present disclosure to provide an improved inertia ring for use with a harmonic damper.

It is another aspect of the present disclosure to incorporate the inertia ring constructed in accordance with the present teaching into a crankshaft damper unit.

It is another aspect of the present disclosure to provide a method of manufacturing an inertia ring for a harmonic damper which results in material savings, reduced product cost and enhanced operational performance.

It is another aspect of the present disclosure to provide a method of cold forming an inertia ring for a harmonic damper from a blank to provide a one-piece component.

It is yet another aspect of the present disclosure to provide a harmonic damper having a cold-formed one-piece inertia ring, a pulley, and an elastomeric damper ring laminated between the pulley and the one-piece inertia ring.

It is yet another aspect of the present disclosure to provide a one-piece inertia ring for use in a harmonic damper having a multi-fold central mass body portion which terminates with a flange portion configured for attachment to the elastomeric damper ring.

In accordance with these and other aspects of the present disclosure, a harmonic damper is provided having an inertia ring that is manufactured via a sheet metal cold forming process. The inertia ring is preferably formed from a blank of low carbon sheet steel having a predetermined thickness. The blank is cold formed through a series of sequential metal forming stations to provide a "folded" inertia ring configuration. The folded or "accordion" type configuration permits a wide variety of inertia rings in terms of ring thickness, ring diameter and weight using the cold forming press and folding manufacturing process of the present disclosure.

Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are for purposes of illustration only and are not intended to limit the scope of the present disclosure.

## DRAWINGS

The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations such that they are not intended to limit the scope of the present disclosure. The following drawings include:

FIG. 1 is a perspective view of an exemplary embodiment of a harmonic damper unit constructed to include an inertia ring manufactured in accordance with the teachings of the present disclosure;

FIG. 2 is a first side view of the harmonic damper unit of FIG. 1;

FIG. 3 is a second side view of the harmonic damper unit of FIG. 1;

FIG. 4 is a sectional view of the harmonic damper unit taken generally along line A-A of FIG. 3;

FIG. 5 is an enlarged partial view of the circled portion of FIG. 4;



3

FIG. 6 is a sectional view of the inertia ring associated with the harmonic damper unit shown in FIGS. 1 through 5, and which embodies the teachings of the present disclosure;

FIG. 7 is a flow chart for an exemplary sequence of processing steps utilized to cold form the inertia ring of FIG. 6 using a manufacturing process in accordance with the teachings of the present disclosure;

FIG. 8 is a perspective view of an accordion-type folded inertia ring after completion of the cold forming operations; and

FIG. 9 is a partially sectioned perspective view of the inertia ring shown in FIG. 8 after final machining.

#### DETAILED DESCRIPTION

One or more exemplary embodiments will now be described more fully with reference to the accompanying drawings.

Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

The present disclosure is generally directed to mass or inertia components of the type well-suited for use in motor vehicle application. In particular, the present disclosure relates to harmonic damper units for use in automotive application. More specifically, a harmonic damper unit, hereinafter described as a crankshaft damper, is adapted to be installed on the crankshaft of an internal combustion engine for driving one or more vehicle accessories via accessory pulleys and an endless drive belt arrangement associated with an engine accessory drive system. To this end, the crankshaft damper is operable to absorb torsional vibrations transmitted by the crankshaft and is hereinafter disclosed as being integrated into an engine pulley assembly. More specifically, the engine pulley assembly is adapted to be rigidly secured to the crankshaft and is used with a V-belt that is wrapped around the outer periphery of the engine pulley assembly. The engine pulley assembly drives various accessories mounted within the vehicle which can include, for example, and alternator, a water pump, and air conditioning compressor, etc. by transmitting the rotary motive power of the crankshaft (produced by the engine) to the accessories via the V-belt.

Referring initially to FIGS. 1-5, an integrated engine pulley and harmonic damper, hereinafter referred to as crankshaft damper 10, constructed in accordance with the teachings of the present disclosure, is generally shown to include a pulley 12, an inertia ring 14 and an elastomeric ring 16 interconnecting inertia ring 14 to pulley 12. Pulley 12 may be formed to include a cup-shaped hub 18, a pulley rim 20 and a radial web plate 22 interconnecting hub 18 to pulley rim 20. Pulley 12 may be manufactured using any known method and, for example, may be manufactured as a hot rolled component made from a low carbon sheet steel or, in the alternative, may be manufactured as a cold formed component from a sheet metal blank using a suitable stamping process. A plurality of apertures 24 are formed in web plate 22 to reduce weight. Cup-shaped hub 18 may include a central mounting aperture 26 that is configured to receive a mechanical fastener, such as

4

a bolt, for rigidly securing pulley 12 to an end of the crankshaft. Pulley rim 20 is generally cylindrical and is formed to include a plurality of V-shaped grooves 28 that are configured to engage the endless drive belt for transferring torque from the crankshaft to the other accessory pulleys for driving the vehicle's accessories.

Inertia ring 14 is a generally ring-shaped member having a central aperture 30 sized to surround an outer cylindrical surface 32 of hub 12. Inertia ring 14 is rigidly secured to hub 12 via a press-fit or a welded connection. Inertia ring 14 further includes an axially extending flange section 34 having an outer peripheral surface 36 that is radially offset relative to an inner peripheral surface 38 of pulley rim 20. As seen, elastomeric ring 16 is disposed between outer peripheral surface 36 of inertia ring 14 and inner peripheral surface 38 of pulley rim 20. Elastomeric ring 16 is pressed into the annular space between flange section 34 and pulley rim 20 and is partially compressed therebetween to resiliently interconnect inertia ring 14 for rotation with pulley 12. An intermediate portion of elastomeric ring 16 is disposed between an annular lip 40 formed on pulley rim 20 and an annular groove 42 formed in flange section 34 to assist in inhibiting axial sliding movement of elastomeric ring 16 relative to inertia ring 14 and pulley 12.

As noted, crankshaft damper 10 is an exemplary embodiment and is merely intended to identify the primary components typically associated with most harmonic dampers of the type used in automotive systems. To this end, the remainder of the present disclosure is directed to a unique construction of inertia ring 14 and a unique method of manufacturing inertial ring 14. More specifically, to a multi-step cold forming method is used to manufacture a "folded" or "accordion-type" inertia ring 14 of the present invention.

Particular reference is drawn to FIG. 6 which shows a sectional view of an exemplary folded version of inertia ring 14 prior to its assembly into crankshaft damper 10 and which embodies the teachings of the present disclosure. Inertia ring 14 is shown to have a first or inner diameter dimension  $D_1$ , a second or outer diameter dimension  $D_2$ , a first width dimension  $W_1$ , and a second width dimension  $W_2$ . Inertia ring 14 is cold formed in a series of consecutive operations from a circular blank having a predetermined constant thickness  $T$ . Alternatively, a variable thickness blank may be used if desired to vary the mass of inertia ring 14 along its radial dimension.

In the particular example shown, a central mass or body portion 50 of inertia ring 14 is configured to be disposed between flange section 34 and central aperture 30 and is formed from a plurality of folded and stacked ring sections 52A, 52B, 52C, 52D, and 52E. Those skilled in the art will recognize that the number, width and length of such folded and stacked ring sections can be varied based on the desired mass and size of the inertia ring. Specifically, first ring section 52A is connected to flange section 34 via a first fold section 54A and both are pressed into engagement along a first axial interface 56A. Second ring section 52B is connected to first ring section 52A via a second fold section 54B and both are in pressed engagement along a second axial interface 56B. Third ring section 52C is connected to second ring section 52B via a third fold section 54C and both are in pressed engagement along a third axial interface 56C. Fourth ring section 52D is connected to third ring section 52C via a fourth fold section 54D and both are in pressed engagement along a fourth axial interface 56D. Finally, fifth ring section 52E is coupled to fourth ring section 52D via a fifth fold section 54E and both are in pressed engagement along a fifth axial interface 56E. As seen, first fold section 54A, third fold section

5

54C and fifth fold section 54E define “inner” fold sections that are aligned along a first or inner face surface 60 of inertia ring 14. Likewise, second fold section 54B and fourth fold section 54D define “outer” fold sections that are aligned along a second or outer face surface 62 of inertia ring 14. While each of the axially-extending annular interfaces 56A, 56B, 56C, 56D and 56E are disclosed to include engagement between adjacent fold sections, it will be understood that such pressed engagement is not necessary to the function of inertia ring 14 and that open or spaced interfaces between adjacent fold sections can be formed if desired.

Following the plurality of cold forming operations required to manufacture the folded configuration of inertia ring 14, it may be necessary to machine first face surface 60 and second face surface 62 to establish the desired first width dimension  $W_1$ . An edge surface 64 of flange section 34 may also be machined to establish the desired second width dimension  $W_2$ . In addition, an inner surface 66 of fifth ring section 52E can be machined to establish the desired inner diameter  $D_1$ , for inertia ring 14. Likewise, outer surface 36 of flange section 34 can be machined to establish the desired outer diameter  $D_2$ . Based on the specific mass and size requirements for different inertia rings, the number and lengths of the folded ring sections can be revised.

With continued reference primarily to FIG. 6, a first void 58A is defined in conjunction with first interface 56A between flange section 34 and first ring section 52A. A second void 58B is defined in conjunction with second interface 56B between first fold section 54A and third fold section 54C. A third void 58C is defined in conjunction with third interface 56C between second fold section 54B and fourth fold section 54D. A fourth void 58D is defined in conjunction with fourth interface 56D between third fold section 54C and fifth fold section 54E. Finally, a fifth void 58E is defined in conjunction with fifth interface 56E between fourth fold section 54D and fifth ring section 52E. These voids are circular in shape and are generally concentric to a centerline 68 of inertia ring 14. The annular voids will be generally v-shaped based on the arcuate edges of the fold sections as each transitions into its corresponding axial interface.

Referring now to FIG. 7, an exemplary process flow chart is provided illustrating a transfer sequence that can be used to manufacture “folded” inertial ring 14. The transfer process flow illustrates various forms of inertia ring 14 as it is fabricated from blank 100 into inertia ring 14. Not all forming sequences are shown, but only those necessary to properly illustrate the series of folding and pressing process steps associated with the present disclosure. Reference number 14' identifies inertia ring 14 after it has optionally been machined. FIGS. 8 and 9 are perspective views of another inertia ring 110 manufactured according to the present invention. The flow chart of FIG. 7 is intended to merely show the configuration of inertia ring 14 at different cold forming operations.

While the present disclosure is generally directed to inertia rings of the type used in harmonic dampers for vehicular applications, it will be appreciated that multi-folded ring components manufactured using the cold forming process of the present disclosure can be used in a plethora of other automotive and non-automotive applications. To this end, the present disclosure may be interpreted to include and encompass ring components having a folded one-piece structure that are manufactured utilizing the cold forming process of the present disclosure.

The foregoing description of the exemplary embodiments has been provided for purposes of illustration and description relating to an inertia ring and a method of making the inertia ring. It is not intended to be exhaustive or to limit the disclo-

6

sure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

The invention claimed is:

1. A harmonic damper comprising:

a pulley having a hub and a pulley rim interconnected by a web plate;

an inertia ring having an inner surface surrounding the hub and an outer surface; and

an elastomeric ring disposed between an inner surface of the pulley rim and the outer surface of the inertia ring for interconnecting the inertia ring to the pulley;

wherein the inertia ring is configured to include a plurality of interconnected ring sections extending between its inner and outer surfaces, and wherein the inertia ring is cold formed from a metal blank to create the plurality of interconnected ring sections.

2. The harmonic damper of claim 1 wherein the hub of the pulley is adapted to be connected to a crankshaft of an internal combustion engine, and wherein the pulley rim is adapted to engage an endless drive belt of an accessory drive system for transferring rotary power from the crankshaft to a remote accessory associated with the accessory drive system.

3. The harmonic damper of claim 1 wherein the inertia ring includes a central mass body portion terminating in a flange section which defines the outer surface, wherein the body portion is ring-shaped has a central aperture defining the inner surface, and wherein the mass body portion is formed from the plurality of the interconnected ring sections.

4. The harmonic damper of claim 3 wherein the plurality of interconnected ring sections includes a first ring section connected to the flange section by a first fold section to define a first axial interface therebetween, and a second ring section connected to the first ring section by a second fold section to define a second axial interface therebetween, and wherein the first ring section is radially disposed between the flange section and the second ring section such that the first axial interface concentrically surrounds the second axial interface.

5. The harmonic damper of claim 4 wherein the plurality of interconnected ring sections further includes a third ring section connected to the second ring section by a third fold section to define a third axial interface therebetween, and a fourth ring section connected to the third ring section by a fourth fold section to define a fourth axial interface therebetween, wherein the third ring section is radially disposed between the second ring section and the fourth ring section such that the second axial interface concentrically surrounds the third axial interface and the third axial interface concentrically surrounds the fourth axial interface, and wherein the first and third fold sections extend along a first face surface of the mass body portion and the second and fourth fold sections extend along a second face surface of the mass body portion.

6. The harmonic damper of claim 5 wherein a width dimension is established between the first and second face surfaces of the mass body portion.

7. The harmonic damper of claim 5 wherein the first axial interface defines engagement between the flange section and the first ring section.

8. The harmonic damper of claim 5 wherein said fourth ring section has an inner surface configured to define the central aperture of the mass body portion of the inertia ring.

7

9. The harmonic damper of claim 5 wherein said inertia ring further includes a fifth ring section connected to the fourth ring section by a fifth fold section to define a fifth axial interface therebetween, wherein the fifth fold section has an inner surface defining the aperture.

10. The harmonic damper of claim 4 wherein the inertia ring is cold formed using a folding and stacking process, wherein the second ring section is formed prior to the first ring section, and wherein the first ring section is formed prior to the flange section.

11. A harmonic damper comprising  
a drive member having a hub;  
an inertia ring having an aperture positioned to surround the hub; and  
a resilient damper disposed between the drive member and the inertia ring;  
wherein the inertia ring includes a mass body portion formed from a plurality of ring sections interconnected by a plurality of fold sections to define a one-piece folded structure.

12. The harmonic damper of claim 11 wherein the damper is an elastomeric ring disposed between an inner surface of the drive member and an outer surface of the mass body portion of the inertia ring, wherein the plurality of interconnected ring sections and fold sections include a first ring section connected to an outer flange section by a first fold section to define a first axial interface therebetween, and a second ring section connected to the first ring section by a second fold section to define a second axial interface therebetween, and wherein the first ring section is radially disposed between the flange section and the second ring section such that the first axial interface concentrically surrounds the second axial interface.

13. The harmonic damper of claim 12 wherein the plurality of interconnected ring sections and fold sections further include a third ring section connected to the second ring section by a third fold section to define a third axial interface therebetween, and a fourth ring section connected to the third ring section by a fourth fold section to define a fourth axial interface therebetween, wherein the third ring section is radially disposed between the second ring section and the fourth ring section such that the second axial interface concentrically surrounds the third axial interface and the third axial interface concentrically surrounds the fourth axial interface, and wherein the first and third fold sections extend along a first face surface of the mass body portion and the second and fourth fold sections extend along a second face surface of the mass body portion.

14. The harmonic damper of claim 13 wherein the inertia ring further includes a fifth ring section connected to the fourth ring section by a fifth fold section to define a fifth axial interface therebetween, wherein the fifth fold section has an inner surface defining the aperture.

15. A harmonic damper for automotive components, comprising:  
a pulley having a hub and pulley rim, the hub and pulley rim being interconnected through a radial web plate,

8

wherein the hub has an outer cylindrical surface and the pulley rim has an inner peripheral surface;

a one-piece inertia ring having a generally ring-shaped member with a central aperture surrounding the outer cylindrical surface of the hub and having an axially extending flange section radially offset from the inner peripheral surface of the pulley rim and a central mass disposed between the flange section and the central aperture; and

an elastomeric ring connecting the inertia ring to the pulley, the elastomeric ring being designed to absorb torsional vibration experienced by the automotive components, wherein the one-piece inertia ring is cold-formed and is folded into an accordion-type shape.

16. The harmonic damper of claim 15, wherein the accordion-type shape includes a plurality of folded and stacked ring sections.

17. The harmonic damper of claim 16, wherein the plurality of folded and stack ring sections include a first ring section connected to the flange section via a first fold section and the first ring section being pressed into engagement along a first axial interface, a second ring section connected to the first ring section via a second fold section and the second ring section being pressed into engagement along a second axial interface, a third ring section connected to the second ring section via a third fold section and the third ring section being pressed into engagement along a third axial interface, a fourth ring section connected to the third ring section via a fourth fold section and the fourth ring section being pressed into engagement along a fourth axial interface, a fifth ring section connected to the fourth ring section via a fifth fold section and the fifth ring section being pressed into engagement along a fifth axial interface, wherein the first, third, and fifth fold sections are inner folds and are aligned with an inner face surface of the inertia ring, and wherein the second and fourth fold sections are outer folds and are aligned along an outer surface of the inertia ring.

18. The harmonic damper of claim 17, wherein the inner face surface of the inertia ring has a first void defined between the flange section and the first ring section and the outer face surface of the inertia ring has a second void defined between the first fold section and the third fold section, and wherein the first void and the second void have a circular shape and are generally concentric to a centerline of the inertia ring.

19. The harmonic damper of claim 18, wherein the inertia ring further includes a third void defined within a third interface between the second fold section and the fourth fold section, a fourth void defined within a fourth interface between the third fold section and the fifth fold section, and a fifth void defined within a fifth interface between the fourth fold section and the fifth ring section.

20. The harmonic damper of claim 15, wherein the elastomeric ring is disposed between an annular lip formed on the pulley rim and an annular groove formed in the flange section for inhibiting axial sliding movement of the elastomeric ring relative to the inertia ring and pulley.

\* \* \* \* \*